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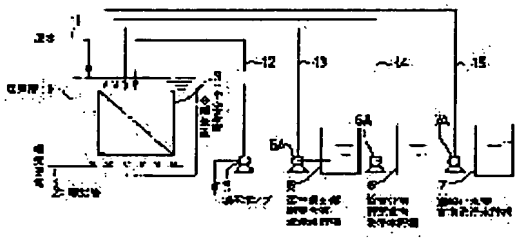
(54) METHOD FOR CLEANING IMMERSION-TYPE MEMBRANE SEPARATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To clean a membrane separator with high safety by injecting a cleaning water contg. protein and/or lipid decomposing enzyme into the membrane separator in an aerobic bioreactor from the permeated liq. outlet side of the membrane.

SOLUTION: A contaminant is deposited on the surface of a membrane due to the operation of a hollow-fiber membrane separator 3, and the amt. of the liq. permeated through the membrane is decreased. In this case, the supply of raw water and a vacuum pump 4 are stopped, and a cleaning water contg. a proteolytic enzyme and/or a cleaning water contg. lipid decomposing enzyme are injected from the permeated liq. side of the membrane. Consequently, the undecomposed protein and lipid depositing on the surface and inside of the membrane are lowered in mol.wt. and removed, and the membrane is cleaned efficiently and safely. Otherwise, the membrane is cleaned with a cleaning water contg. proteolytic enzyme and/or lipid decomposing enzyme, and then a cleaning water contg. hydrogen peroxide is injected from the permeated water outlet side of the membrane. Protease, etc., and lipase, etc., are respectively used as the proteolytic enzyme and lipid decomposing enzyme.



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* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the washing approach of a dipping former membrane separation device, and relates the film of the membrane separation device by which immersion installation was especially carried out into the aerobic organism processing reaction vessel or the tub connected with this to insurance and the approach of washing efficiently.
[0002]
[Description of the Prior Art] The aerobic organism processor with a membrane-separation machine immersed in the aerator of an activated sludge process equipment or biological-contact-aeration equipment in MF (precision filtration) film and UF (ultrafiltration) membrane module of a hollow filament configuration for the purpose of being stabilized and obtaining miniaturization of a waste-water-treatment facility and the advanced quality of treated water in recent years in a union septic tank and various other life system waste-water-treatment facilities is developed.
[0003] thus, the amount of water of raw water since the living thing concentration in a biological treatment reaction vessel can be raised while a settling tank becomes unnecessary by immersing a hollow fiber module in an aerator -- it becomes possible to perform continuously advanced processing stabilized also to fluctuation or water quality fluctuation, and up, it becomes that there is also that no SS of sludge or raw water flows out into treated water, and operation management turns for it to be easy.
[0004] However, various pollutants, such as protein in raw water and a lipid, adhere to the membrane module immersed in the aerator on the surface of the film, and membranous penetrable ability is sharply reduced by the passage of time. Therefore, it is necessary to wash the film and to recover penetrable ability by adhesion of a pollutant, when membranous penetrable ability falls.
[0005] The chemical (JP,3-77629,A, 4-131182 official report) cleaning method which removes various kinds of pollutants which poured in these wash water and adhered on the surface of the film from the membranous permeate liquid side (secondary) in the condition [that the film picked out from the aerator is immersed as a washing means of this film into the wash water containing a hydrochloric acid, caustic soda, or sodium hypochlorite, or the film has been conventionally immersed in the aerator] is common.
[0006]
[Problem(s) to be Solved by the Invention] The approach of picking out the film from an aerator among the above-mentioned conventional chemical washing approaches takes membranous ejection and the immersion activity of the film after washing, and it is not efficient. Although the ejection of this film and the immersion activity of the film after washing became unnecessary and efficient washing could be performed when it was the approach of washing the film in the condition [having been immersed in the aerator], there were the following problems by the conventional washing approach using chemicals, such as a hydrochloric acid, and caustic soda, sodium hypochlorite.
[0007] That is, when the protein and the lipid whose pollutant on the front face of the film is not disassembled were a subject, washing actuation, such as being unable to acquire cleaning effect sufficient in such chemical washing, but using so much and frequently high concentration caustic soda and sodium hypochlorite which raised temperature, or washing further using a hydrochloric acid, after using caustic soda and sodium hypochlorite, was complicated. And in such a cleaning

method, there was also a problem that the worker of the speciality in which it had a technique with advanced washing since the chemical for washing was a thing accompanied by danger to the time of use needed to carry out to the origin of sufficient management.
[0008] On the other hand, since increasing increasingly is predicted, adoption of the aerator which it was necessary to process highly the life system wastewater which contains protein and a lipid in high concentration with compacter equipment from now on, therefore was immersed in the membrane module can wash the immersion film more effectively, and to establish the high washing approach of safety moreover is desired.
[0009] This invention solves the above-mentioned conventional trouble, and it aims at offering the washing approach of the dipping former membrane separation device which washes efficiently the membrane separation device by which immersion installation was carried out into the aerobic organism processing reaction vessel or the tub connected with this with high safety.
[0010]
[Means for Solving the Problem] The washing approach of the dipping former membrane separation device of this invention is characterized by pouring in and washing the wash water containing the wash water containing a proteolytic enzyme, and/or a lipolytic enzyme from a membranous permeate liquid outflow side in the approach of washing the membrane separation device by which immersion installation was carried out into the aerobic organism processing reaction vessel or the tub connected with this biological treatment reaction vessel.
[0011] While carrying out depolymerize of the pollutant which consists of the protein and the lipid which are not decomposed adhering to the front face or the interior of membranous efficiently in washing the film to which penetrable ability fell by adhesion of a pollutant when the life system wastewater which contained protein and a lipid in high concentration is processed with the aerobic organism processor which incorporated the hollow-fiber module, it is necessary to eliminate the pollutant which carried out depolymerize from the front face and the interior of membranous.
[0012] It considers as the means to which depolymerize of the pollutant which consists of protein adhering to a film surface or a lipid in this invention is carried out. This enzyme content wash water is made to flow in the film from a film permeate liquid side (secondary) using the wash water containing a proteolytic enzyme or a lipolytic enzyme. In case the enzyme in wash water penetrates to a membranous raw water side (upstream), insurance and efficient washing are performed by carrying out depolymerize of the pollutant adhering to the inside of the film, or a film front face.
[0013] Furthermore, after performing washing by such enzyme, a still higher cleaning effect can be acquired by carrying out exfoliation exclusion of the pollutant which carried out depolymerize with the oxygen air bubbles which pour in the wash water containing a hydrogen peroxide from a membranous permeate liquid side (secondary), and disassemble the pollutant by which depolymerize was carried out with the enzyme, and are generated in disassembly of a hydrogen peroxide from a film surface.
[0014]
[Embodiment of the Invention] Hereafter, this invention is explained to a detail with reference to a drawing.
[0015] Drawing 1 </A> is the schematic diagram showing one example of the washing approach of the dipping former membrane separation device of this invention, and shows the example which applied this invention approach to washing of the hollow fiber module of a hollow fiber dipping former activated sludge process equipment.
[0016] One is an aerator among drawing, and it has the aeration tubing 2 and is immersed in CHUBU ENGINEERING CORPORATION in the hollow fiber decollator 3. 4 is a reduced pressure pump and 5, 6, and 7 are the tanks of proteolytic enzyme content wash water, lipolytic enzyme content wash water, and hydrogen-peroxide content wash water respectively. As for each sign of a pump, and 11-15, 5A, 6A, and 7A show piping.
[0017] First, a configuration, a service condition, etc. of this example equipment are explained.
[0018] In this example, raw water is life system wastewater represented by kitchen wastewater, and contains protein and a lipid in addition to a carbohydrate. Fundamentally, although raw water is introduced into this activated sludge process equipment after storing it in a waste water equalizing tank, it is also possible to exclude a waste water equalizing tank, when there are few amounts of raw

water, and to introduce directly.
[0019] Although the amount operation of heavy loads burden 5 kg-BOD/m3 and more than day is also possible, as for an aerator 1, it is desirable to operate by below 2 kg-BOD/m3 and day also from the field which reduces the amount of generating sludge from a viewpoint which prevents fluctuation of the quality of treated water accompanying raw water fluctuation.
[0020] The membrane separation device 3 immersed in this aerator 1 makes the film permeate liquid corresponding to the amount of water flow discharge from this membrane separation device 3 using hollow fiber-like MF film or UF film. Although there are an approach of making the interior of a hollow fiber reduced pressure, using the reduced pressure pump 4 or a vacuum pump as a discharge means of this permeate liquid, and attracting permeate liquid like illustration and an approach into which make the whole tub into a pressurization condition and permeate liquid is made to flow using the pressure in that tub, the approach of making the interior of a hollow fiber reduced pressure from a structure side or an operation side, and attracting permeate liquid is suitable. Under the present circumstances, the coating weight of the pollutant on the front face of the film can be reduced by adopting the intermittent suction method which performs a fixed time amount suction pause for several minutes after fixed time amount suction for [10 minutes -] 30 minutes, without considering as the method which attracts permeate liquid continuously.
[0021] In the equipment of this example, biological treatment of the raw water introduced into the aerator 1 from piping 11 is aerobically carried out with the aeration air from the aeration tubing 2, and it is processed with the hollow fiber decollator 3 after that. The permeate liquid of a hollow fiber is discharged out of a system from piping 12 by suction with the reduced pressure pump 4.
[0022] When a pollutant adheres to a film surface by operation of equipment and the membranous amount of permeate liquid decreases, installation and the reduced pressure pump 4 of raw water are suspended, the wash water which contained the enzyme according to this invention approach is pressed fit from the permeate liquid side (secondary), and depolymerize thru/or washing which it is made to dissolve and is the film are performed for the pollutant on the front face of the film.
[0023] In this invention, lipase-P, Lipozyme, etc. have subtilisin, usable protease-N, etc. as a lipolytic enzyme as a proteolytic enzyme used for enzyme washing. Especially when the raw water of the membrane separation device washed especially makes a subject kitchen wastewater of the general home where activated sludge treatment is performed, it is appropriate to use further the wash water which contains lipase-P (product made from Amano Pharmaceuticals) especially 5% of the weight 0.5 to 10% of the weight as a lipolytic enzyme using the wash water which contains protease-N (product made from Amano Pharmaceuticals) 2% of the weight 0.5 to 10% of the weight as a proteolytic enzyme. The amount of wash water is 1 - 3 kg/cm2 as a washing pressure, although based on a membranous contamination situation. It is pressurized wash water 1m of film surface products 2 It per 1-5L (liter) Uses, and it is desirable for at least 30 minutes to wash on conditions to which wash water piles up in the film.
[0024] In case especially the point which it should be careful of in operation of this invention uses a proteolytic enzyme and a lipolytic enzyme together, it is a point which does not mix both enzymes. That is, in using a proteolytic enzyme and a lipolytic enzyme together since a lipolytic enzyme may be inactivated with a proteolytic enzyme if both enzymes are mixed, after the wash water containing a proteolytic enzyme surely washes, the wash water containing a lipolytic enzyme washes. Or after the wash water containing a lipolytic enzyme washes, the wash water containing a proteolytic enzyme washes.
[0025] In addition, since the enzyme with enough much activity is contained in the washing effluent after washing, it is also possible to use for the zymolysis of the protein in the liquid in an aerator or a lipid the activity of the enzyme which remains to the washing effluent. When the activity of an aerator of the active sludge in an aerator is high in the state of aeration in that case, since it will be decomposed by active sludge, in order to utilize the enzyme activity of a residual enzyme effectively, as for the residual enzyme in a washing effluent, it is desirable to suspend aeration primarily and to put the inside of a tub on a loose churning condition. By suspending aeration, the activity of active sludge falls temporarily and disassembly of an enzyme is prevented.
[0026] In this invention, after carrying out enzyme washing with these means, while disassembling the pollutant by which poured in the wash water containing 2 - 3% of the weight of a hydrogen

peroxide from the membranous permeate liquid side (secondary), and depolymerize was carried out with the enzyme, it is desirable to carry out exfoliation exclusion from a film surface with the oxygen air bubbles generated at the time of disassembly of a hydrogen peroxide.
[0027] In addition, aeration is performed, or churning in an aerator is fully performed, and the washing effluent containing a hydrogen peroxide is made to diffuse and dilute promptly in a tub at the time of washing by this hydrogen peroxide. That is, although the hydrogen peroxide which remains in a washing effluent is effectively used as an oxygen supply to active sludge, when hydrogen-peroxide concentration is high concentration, the activity of active sludge is checked. Therefore, while adjusting an injection rate and grouting velocity so that the hydrogen-peroxide concentration after the washing effluent was diluted with the mixed liquor in an aerator may become 2000 or less mg/L in washing by this hydrogen peroxide, it is necessary to perform sufficient mixing and churning.
[0028] In the equipment shown in drawing 1 , the concrete washing actuation is as follows.
[0029] That is, while suspending installation of raw water, after suspending aeration and the reduced pressure pump 4 first, pump 5A is operated and predetermined time impregnation of the proteolytic enzyme content wash water in a tank 5 is carried out by the predetermined flow rate from the permeate liquid side of a membrane separation device 3 through piping 13.
[0030] While stopping pump 5A after that, pump 6A is operated and predetermined time impregnation of the lipolytic enzyme content wash water in a tank 6 is carried out by the predetermined flow rate from the permeate liquid side of a membrane separation device 3 through piping 14.
[0031] Thus, after performing washing by the proteolytic enzyme, and washing by the lipolytic enzyme, washing by the hydrogen peroxide is performed.
[0032] That is, while stopping pump 6A, pump 7A is operated and predetermined time impregnation of the hydrogen-peroxide content wash water in a tank 7 is carried out by the predetermined flow rate from the permeate liquid side of a membrane separation device 3 through piping 15.
[0033] Under the present circumstances, in order to make the residual hydrogen peroxide in a washing effluent diffuse and dilute in a tub promptly like the above-mentioned, aeration is resumed and sufficient churning is performed.
[0034] It operates the reduced pressure pump 4 and resumes processing while after washing by the hydrogen peroxide stops pump 7A and introduces raw water.
[0035] In addition, although the equipment of illustration installs a hollow fiber decollator in an aerator, this invention can carry out immersion installation of the membrane separation device into another tub connected with the living thing reaction vessel, and can apply it also to washing of the equipment which adopted the method which transports liquid in the tank with the means of a pump, an air lift pump, etc. between a living thing reaction vessel and a film installation tub.
[0036] Moreover, you may be the film of the gestalt of others also as a gestalt of the film to wash, such as not only a hollow fiber but a flat film, tubular film, etc.
[0037]
[Example] An example is given to below and this invention is more concretely explained to it.
[0038] SS:300 discharged from the kitchen of an example 1, the example 1 of a comparison, and two dining-rooms - 2200 mg/L, 3300 [BOD:500 -] mg/L, 1200 [N-hexane fusibility matter (lipid origin):70 -] mg/L, organic nitrogen (protein origin): The cleaning effect by this invention was investigated in equipment as shows wastewater of 30 - 550 mg/L to drawing 1 used as raw water.
[0039] Aerator capacity is 1000L and is 2 4m of effective-surface products as hollow filament UF film in this aerator. 3 sets was immersed in "Stera pore-L (the fractionation property of 0.1 micrometers, film material polyethylene)" by Mitsubishi Rayon Co., Ltd. (all the effective-surface products of a hollow fiber are 2 12m). The amount of raw water water flow to equipment set the burden per 600 L/day and aerator capacity to 0.3 - 2.0 kg-BOD/m3 and day.
[0040] The sludge concentration in an aerator was adjusted to 10000 mg/L, and the water temperature in an aerator was made into 24-28 degrees C. Aeration was performed from the aerator pars basilaris ossis occipitalis, and held DO concentration of the liquid in an aerator to 3 or more mg/L. Treated water was drawn [from the permeate liquid outflow side of the hollow filament UF film] out using the reduced pressure pump per each hollow filament UF film and by 200 L/day (they

are 600 L/day at 3 sets) under reduced pressure (a pressure -0.05 - -0.1 kg/cm2). Drawing of this permeate liquid was made into the intermittent method of a pause for suction and 2 minutes for 20 minutes.

[0041] Continuous running was performed for one month the above condition, and the quality of a flood less than [BOD:20 mg/L] and not more than N-hexane fusibility matter:5 mg/L was obtained to stability as film permeate liquid (treated water) water quality.

[0042] 3 sets of hollow filament UF film was separately washed by the following approach one month after continuous running. The amount of the maximum permeate liquid before and behind washing was measured using tap water with a water temperature of 25 degrees C, and the result was shown in Table 1.

[0043] Example 1: It let protein content wash water flow for 30 minutes from the permeate liquid outflow side of the hollow filament UF film by the amount of water of 1 L/hr previously using the proteolytic enzyme content wash water which dissolved protease-N in tap water 2% of the weight as a proteolytic enzyme, and the lipolytic enzyme content wash water which dissolved lipase-P in tap water 5% of the weight as a lipolytic enzyme. Next, it let lipolytic enzyme content wash water flow for 30 minutes on these conditions by the same approach. It let flow the tap water which finally contained the hydrogen peroxide 3% of the weight for 30 minutes.

[0044] It let the 1:4 % of the weight caustic soda water solution (temperature of 70 degrees C) of examples of a comparison flow for 30 minutes from the membranous permeate liquid outflow side by the amount of water of 2 L/hr, and after that, it let tap water flow from the permeate liquid outflow side until it let the hydrochloric-acid water solution flow similarly by the amount of water of 2 L/hr 5% of the weight for 30 minutes and pH of permeate liquid finally became neutrality.

[0045] The example 2 of a comparison: It washed like the example 1 of a comparison except having used 4% of the weight of the sodium hypochlorite water solution (temperature of 70 degrees C) instead of the caustic soda water solution.

[0046]

[Table 1]

例	洗浄前の最大透過液量 (m^3/m^2・day) (カッコ内は吸引圧力)	洗浄後の最大透過液量 (m^3/m^2・day) (カッコ内は吸引圧力)
実施例1	0．44 (−0．32kg／cm)	1．33 (−0．32kg／cm)
比較例1	0．44 (−0．32kg／cm)	0．74 (−0．33kg／cm)
比較例2	0．44 (−0．32kg／cm)	0．89 (−0．33kg／cm)

[0047] According to the washing approach of this invention by the proteolytic enzyme, and a lipolytic enzyme and a hydrogen peroxide, it is more distinct than Table 1 that can obtain one 1.5 to 1.8 times the amount of the maximum permeate liquid of this, and washing effectiveness is sharply improved compared with the conventional washing approach using caustic soda, a hydrochloric acid, or sodium hypochlorite and a hydrochloric acid.

[0048]

[Effect of the Invention] Since the ** film can be efficiently washed according to the washing approach of the dipping former membrane separation device of this invention as explained in full detail above, washing frequency can be reduced.

** By washing by the enzyme, since a dangerous chemical is not needed on handling, washing is easy and it becomes unnecessary [the advanced management by the special worker].

** Since it becomes possible to discharge a washing effluent in a biological treatment reaction vessel, washing effluent processing becomes unnecessary.

** A hydrogen peroxide is [the enzyme which remains in a washing effluent] effectively utilizable for the zymolysis of the protein in biological treatment reaction liquid in the tank, or a lipid as an oxygen supply of active sludge again, respectively.

The said effectiveness is done so and the membrane separation device by which immersion installation was carried out into the aerobic organism processing reaction vessel or the tub connected with this can be efficiently washed with high safety.

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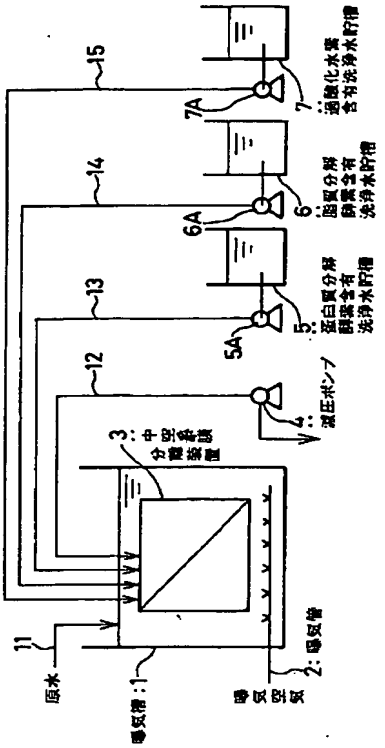
Drawing selection Representative drawing



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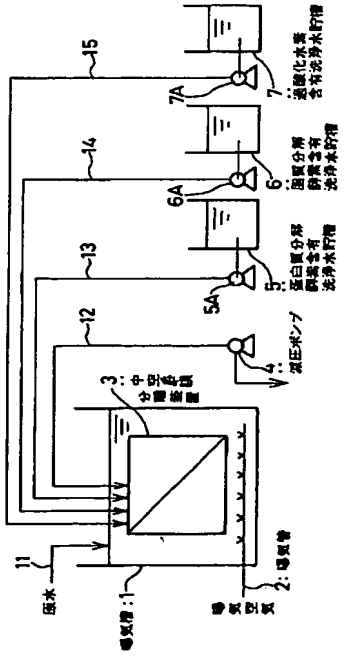
(54)【発明の名称】　浸漬型膜分離装置の洗浄方法

(57)【要約】
【課題】　好気性生物処理反応槽又は、これに連結された槽内に浸漬設置された膜分離装置を高い安全性にて効率的に洗浄する。
【解決手段】　蛋白質分解酵素を含む洗浄水及び／又は脂質分解酵素を含む洗浄水を膜の透過液流出側から注入する。
【効果】　蛋白質分解酵素や脂質分解酵素を含んだ洗浄水を、膜透過液側から膜内に流入させ、洗浄水中の酵素が膜の原水側に透過する際に、膜内や膜表面に付着している汚染物質を低分子化させることにより、安全かつ効率的な洗浄を行える。



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【特許請求の範囲】

【請求項１】　好気性生物処理反応槽内又は、該生物処理反応槽と連結された槽内に浸漬設置された膜分離装置を洗浄する方法において、蛋白質分解酵素を含む洗浄水及び／又は脂質分解酵素を含む洗浄水を膜の透過液流出側から注入して洗浄することを特徴とする浸漬型膜分離装置の洗浄方法。

【請求項２】　請求項１に記載の方法において、蛋白質分解酵素を含む洗浄水及び／又は脂質分解酵素を含む洗浄水で洗浄を行った後、過酸化水素を含む洗浄水を膜の透過液流出側から注入することを特徴とする浸漬型膜分離装置の洗浄方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は浸漬型膜分離装置の洗浄方法に係り、特に、好気性生物処理反応槽又は、これに連結された槽内に浸漬設置された膜分離装置の膜を安全かつ効率的に洗浄する方法に関する。

【０００２】

【従来の技術】近年、合併浄化槽、その他の各種生活系排水処理設備において、排水処理設備のコンパクト化と高度な処理水質を安定して得ることを目的として、活性汚泥処理装置や接触曝気処理装置の曝気槽内に中空糸形状のＭＦ（精密濾過）膜やＵＦ（限外濾過）膜モジュールを浸漬した膜分離機付き好気性生物処理装置が開発されている。

【０００３】このように曝気槽内に中空糸膜モジュールを浸漬することにより、沈澱槽が不要になるとともに、生物処理反応槽内の生物濃度を高めることができることから、原水の水量変動や水質変動に対しても安定した高度な処理を継続的に行うことが可能となる上に、処理水中に汚泥や原水のＳＳが流出することも皆無となって、運転管理が容易となる。

【０００４】しかしながら、曝気槽に浸漬した膜モジュールには、膜の表面に原水中の蛋白質や脂質等の種々の汚染物質が付着し、経時により膜の透過性能を大幅に低減させる。そのため、汚染物質の付着により、膜の透過性能が低下した場合には、膜の洗浄を行って透過性能を回復させることが必要となる。

【０００５】従来、この膜の洗浄手段としては、塩酸やカセイソーダ、又は次亜塩素酸ソーダを含有した洗浄水中に曝気槽から取り出した膜を浸漬するか、或いは、膜を曝気槽に浸漬したままの状態で膜の透過液側（二次側）からこれらの洗浄水を注入して、膜の表面に付着した各種の汚染物質を除去する（特開平３－７７６２９号公報，同４－１３１１８２号公報）薬品洗浄法が一般的である。

【０００６】

【発明が解決しようとする課題】上記従来の薬品洗浄方法のうち、膜を曝気槽から取り出す方法では、膜の取り出し、洗浄後の膜の浸漬作業を要し、効率的ではない。曝気槽に浸漬したままの状態で膜を洗浄する方法であれば、この膜の取り出し、洗浄後の膜の浸漬作業が不要となり、効率的な洗浄を行えるが、塩酸やカセイソーダ、次亜塩素酸ソーダ等の薬品を用いる従来の洗浄方法では、次のような問題があった。

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【０００７】即ち、膜表面の汚染物質が未分解の蛋白質や脂質が主体である場合には、このような薬品洗浄では十分な洗浄効果を得ることができず、温度を高めた高濃度なカセイソーダや次亜塩素酸ソーダを多量に、かつ頻繁に使用したり、カセイソーダや次亜塩素酸ソーダを用いた後、更に塩酸を使用して洗浄を行うなど、洗浄操作が煩雑であった。しかも、このような洗浄法では洗浄用の薬品が使用時に危険性を伴うものであるため、洗浄作業は高度な技術を持った専門の作業員が十分な管理の元に行う必要があるといった問題もあった。

【０００８】一方で、今後、蛋白質や脂質を高濃度に含有する生活系排水を、よりコンパクトな装置で高度に処理することが必要となり、そのために、膜モジュールを浸漬した曝気槽の採用は、益々増加することが予測されることから、浸漬膜をより効果的に洗浄することができ、しかも安全性の高い洗浄方法を確立することが望まれている。

【０００９】本発明は上記従来の問題点を解決し、好気性生物処理反応槽又は、これに連結された槽内に浸漬設置された膜分離装置を高い安全性にて効率的に洗浄する浸漬型膜分離装置の洗浄方法を提供することを目的とする。

【００１０】

【課題を解決するための手段】本発明の浸漬型膜分離装置の洗浄方法は、好気性生物処理反応槽内又は、該生物処理反応槽と連結された槽内に浸漬設置された膜分離装置を洗浄する方法において、蛋白質分解酵素を含む洗浄水及び／又は脂質分解酵素を含む洗浄水を膜の透過液流出側から注入して洗浄することを特徴とする。

【００１１】蛋白質や脂質を高濃度に含んだ生活系排水を、中空糸膜モジュールを組み入れた好気性生物処理装置で処理した場合、汚染物質の付着により透過性能が低下した膜を洗浄するに当っては、膜の表面や内部に付着した未分解の蛋白質や脂質からなる汚染物質を効率的に低分子化させるとともに、膜の表面や内部から低分子化した汚染物質を排除することが必要となる。

【００１２】本発明においては、膜面に付着した蛋白質や脂質からなる汚染物質を低分子化させる手段として、蛋白質分解酵素や脂質分解酵素を含んだ洗浄水を用い、この酵素含有洗浄水を膜透過液側（二次側）から膜内に流入させ、洗浄水中の酵素が膜の原水側（一次側）に透過する際に、膜内や膜表面に付着している汚染物質を低分子化させることにより、安全かつ効率的な洗浄を行う。

【００１３】更に、このような酵素による洗浄を行った後、過酸化水素を含有する洗浄水を膜の透過液側（二次側）から注入し、酵素により低分子化された汚染物質を分解し、また、過酸化水素の分解で発生する酸素気泡により低分子化した汚染物質を膜面から剥離排除させることにより、より一層高い洗浄効果を得ることができる。

【００１４】

【発明の実施の形態】以下、図面を参照して本発明を詳細に説明する。

【００１５】図１は、本発明の浸漬型膜分離装置の洗浄方法の一実施例を示す系統図であって、中空糸膜浸漬型活性汚泥処理装置の中空糸膜モジュールの洗浄に本発明方法を適用した例を示すものである。

【００１６】図中、１は曝気槽であり、曝気管２を備え、中部には中空糸膜分離装置３が浸漬されている。４は減圧ポンプ、５，６，７は、各々、蛋白質分解酵素含有洗浄水、脂質分解酵素含有洗浄水、過酸化水素含有洗浄水の貯槽である。５Ａ，６Ａ，７Ａはポンプ、１１～１５の各符号は配管を示す。

【００１７】まず、本実施例装置の構成及び運転条件等について説明する。

【００１８】本実施例において、原水は、厨房排水に代表される生活系排水であり、炭水化物以外に蛋白質や脂質を含むものである。基本的には原水は原水調整槽に貯留した後、この活性汚泥処理装置に導入するが、原水量が少ない場合は原水調整槽を省き、直接導入することも可能である。

【００１９】曝気槽１は、負荷量５Ｋｇ－ＢＯＤ／m^3・ｄａｙ以上の高負荷量運転も可能であるが、原水変動に伴う処理水質の変動を防止する観点から、また発生汚泥量を低減させる面からも２Ｋｇ－ＢＯＤ／m^3・ｄａｙ以下で運転することが好ましい。

【００２０】この曝気槽１に浸漬された膜分離装置３は、中空糸膜状のＭＦ膜又はＵＦ膜を用いたものであり、この膜分離装置３からは通水量に見合った膜透過液を排出させる。この透過液の排出手段としては、図示の如く、減圧ポンプ４又は真空ポンプを用いて中空糸膜内部を減圧にして透過液を吸引する方法と、槽全体を加圧状態とし、その槽内の圧力を利用して透過液を流出させる方法とがあるが、構造面や運転操作面からは中空糸膜内部を減圧にして透過液を吸引する方法が適当である。この際、連続的に透過液を吸引する方式とせずに、１０分～３０分間の一定時間吸引後、数分間の一定時間吸引休止を行う間欠吸引方式を採用することにより、膜表面への汚染物質の付着量を低減することができる。

【００２１】本実施例の装置において、配管１１より曝気槽１に導入された原水は、曝気管２からの曝気空気で好気的に生物処理され、その後、中空糸膜分離装置３で処理される。中空糸膜の透過液は、減圧ポンプ４による吸引で、配管１２より系外へ排出される。

【００２２】装置の運転により膜面に汚染物質が付着して膜の透過液量が低減した場合には、原水の導入及び減圧ポンプ４を停止し、本発明方法に従って酵素を含んだ洗浄水を透過液側（二次側）から圧入して膜表面の汚染物質を低分子化ないし溶解させて膜の洗浄を行う。

【００２３】本発明において、酵素洗浄に用いる蛋白質分解酵素としては、ズブチリシンやプロテアーゼ－Ｎ等が、脂質分解酵素としてはリパーゼ－Ｐやリポザイム等が使用可能である。特に、洗浄する膜分離装置の原水が、活性汚泥処理が行われている一般的な家庭の厨房排水を主体とする場合には、蛋白質分解酵素としてプロテアーゼ－Ｎ（天野製薬（株）製）を０．５～１０重量％、特に２重量％含む洗浄水を用い、更に、脂質分解酵素としてリパーゼ－Ｐ（天野製薬（株）製）を０．５～１０重量％、特に５重量％含む洗浄水を用いることが適当である。洗浄水量は膜の汚染状況によるが、洗浄圧力として１～３Ｋｇ／ｃm^2に加圧した洗浄水を膜面積１m^2当たり１～５Ｌ（リットル）用い、最低３０分間は膜内に洗浄水が滞留するような条件で洗浄を行うことが好ましい。

【００２４】本発明の実施に当り、特に注意すべき点は、蛋白質分解酵素と脂質分解酵素とを併用する際、両酵素を混合しない点である。即ち、両酵素を混合すると、脂質分解酵素が蛋白質分解酵素により不活性化される可能性があるため、蛋白質分解酵素と脂質分解酵素とを併用する場合には、必ず、蛋白質分解酵素を含む洗浄水で洗浄した後、脂質分解酵素を含む洗浄水で洗浄する。或いは、脂質分解酵素を含む洗浄水で洗浄した後、蛋白質分解酵素を含む洗浄水で洗浄する。

【００２５】なお、洗浄後の洗浄排液中には、十分に多くの活性を持った酵素が含まれているため、洗浄排液に残留している酵素の活性を、曝気槽内液中の蛋白質や脂質の酵素分解に利用することも可能である。その際、曝気槽が曝気状態で曝気槽内の活性汚泥の活性が高いと、洗浄排液中の残留酵素は活性汚泥により分解されてしまうため、残留酵素の酵素活性を有効に活用するためには、曝気を一次停止して、槽内を緩やかな撹拌状態に置くことが好ましい。曝気を停止することで、活性汚泥の活性は一時的に低下し酵素の分解が防止される。

【００２６】本発明においては、これらの手段で酵素洗浄した後、２～３重量％の過酸化水素を含有する洗浄水を、膜の透過液側（二次側）から注入し、酵素により低分子化された汚染物質を分解すると共に、過酸化水素の分解時に発生する酸素気泡により膜面から剥離排除するのが好ましい。

【００２７】なお、この過酸化水素による洗浄時には、曝気を行うか、又は曝気槽内の撹拌を十分に行い、過酸化水素を含んだ洗浄排液を槽内に速やかに拡散・希釈させる。即ち、洗浄排液中に残留している過酸化水素は、活性汚泥への酸素供給源として有効に使用されるが、過

酸化水素濃度が高濃度の時は活性汚泥の活性が阻害される。そのため、この過酸化水素による洗浄に当っては、洗浄排液が曝気槽内混合液で希釈された後の過酸化水素濃度が２０００ｍｇ／Ｌ以下になるように、注入量や注入速度を調整すると共に、十分な混合、撹拌を行う必要がある。

【００２８】図１に示す装置において、具体的な洗浄操作は次の通りである。

【００２９】即ち、まず、原水の導入を停止すると共に、曝気及び減圧ポンプ４を停止した後、ポンプ５Ａを作動させて貯槽５内の蛋白質分解酵素含有洗浄水を配管１３を経て膜分離装置３の透過液側より所定の流量で所定時間注入する。

【００３０】その後ポンプ５Ａを停止すると共に、ポンプ６Ａを作動させて、貯槽６内の脂質分解酵素含有洗浄水を配管１４を経て膜分離装置３の透過液側より、所定の流量で所定時間注入する。

【００３１】このようにして蛋白質分解酵素による洗浄及び脂質分解酵素による洗浄を行った後は、過酸化水素による洗浄を行う。

【００３２】即ち、ポンプ６Ａを停止すると共に、ポンプ７Ａを作動させて、貯槽７内の過酸化水素含有洗浄水を配管１５を経て膜分離装置３の透過液側より、所定の流量で所定時間注入する。

【００３３】この際、前述の如く、洗浄排液中の残留過酸化水素を速やかに槽内に拡散・希釈させるために、曝気を再開するなどして十分な撹拌を行う。

【００３４】過酸化水素による洗浄後は、ポンプ７Ａを停止して、原水の導入を行うと共に、減圧ポンプ４を作動させて処理を再開する。

【００３５】なお、図示の装置は、曝気槽内に中空糸膜分離装置を設置したものであるが、本発明は、生物反応槽と連結している別な槽内に膜分離装置を浸漬設置し、生物反応槽と膜設置槽との間でポンプやエアーリフトポンプ等の手段で槽内液を移送する方式を採用した装置の洗浄にも適用可能である。

【００３６】また、洗浄する膜の形態としても、中空糸膜に限らず、例えば平膜、チューブラー膜等の他の形態の膜であっても良い。

【００３７】

【実施例】以下に実施例を挙げて本発明をより具体的に説明する。

【００３８】実施例１，比較例１，２

食堂の厨房から排出されるＳＳ：３００～２２００ｍｇ／Ｌ、ＢＯＤ：５００～３３００ｍｇ／Ｌ、Ｎ－ヘキサン可溶性物質（脂質由来）：７０～１２００ｍｇ／Ｌ、有機体窒素（蛋白質由来）：３０～５５０ｍｇ／Ｌの排水を原水とする図１に示すような装置において、本発明による洗浄効果を調べた。

【００３９】曝気槽容量は１０００Ｌで、この曝気槽内に、中空糸ＵＦ膜として、有効表面積４ｍ² の三菱レイヨン（株）製「ステラポアーＬ（分画特性０．１μｍ、膜素材ポリエチレン）」を３組浸漬した（中空糸膜の全有効表面積は１２ｍ² ）。装置への原水通水量は６００Ｌ／ｄａｙ、曝気槽容量当たりの負荷量は０．３～２．０Ｋｇ－ＢＯＤ／ｍ³ ・ｄａｙとした。

【００４０】曝気槽内の汚泥濃度は１００００ｍｇ／Ｌに調整し、曝気槽内水温は２４～２８℃とした。曝気は曝気槽底部から行い、曝気槽内液のＤＯ濃度を３ｍｇ／Ｌ以上に保持した。処理水は中空糸ＵＦ膜の透過液流出側から減圧ポンプを用いて、減圧下（圧力－０．０５～－０．１Ｋｇ／ｃｍ² ）、各中空糸ＵＦ膜当り、２００Ｌ／ｄａｙ（３組で６００Ｌ／ｄａｙ）で引き抜いた。この透過液の引き抜きは、２０分間吸引、２分間休止の間欠方式とした。

【００４１】以上の条件で連続運転を１ケ月間行い、膜透過液（処理水）水質としては、ＢＯＤ：２０ｍｇ／Ｌ以下、Ｎ－ヘキサン可溶性物質：５ｍｇ／Ｌ以下の高水質を安定に得た。

【００４２】連続運転１ケ月後に３組の中空糸ＵＦ膜を下記の方法で別々に洗浄した。洗浄前後の最大透過液量を水温２５℃の水道水を用いて測定し、結果を表１に示した。

【００４３】実施例１：蛋白質分解酵素としてプロテアーゼ－Ｎを水道水に２重量％溶解した蛋白質分解酵素含有洗浄水と、脂質分解酵素としてリパーゼ－Ｐを水道水に５重量％溶解した脂質分解酵素含有洗浄水とを用い、先に蛋白質含有洗浄水を１Ｌ／ｈｒの水量で中空糸ＵＦ膜の透過液流出側から３０分間通水した。次に、同様な方法で脂質分解酵素含有洗浄水を同条件で３０分間通水した。最後に過酸化水素を３重量％含んだ水道水を３０分間通水した。

【００４４】比較例１：４重量％カセイソーダ水溶液（温度７０℃）を、２Ｌ／ｈｒの水量で膜の透過液流出側から３０分間通水し、その後、５重量％塩酸水溶液を２Ｌ／ｈｒの水量で同様に３０分通水し、最後に透過液のｐＨが中性になるまで、水道水を透過液流出側から通水した。

【００４５】比較例２：カセイソーダ水溶液の代りに４重量％の次亜塩素酸ソーダ水溶液（温度７０℃）を用いたこと以外は比較例１と同様にして洗浄を行った。

【００４６】

【表１】

例	洗浄前の最大透過液量 (㎥／㎡・day) (カッコ内は吸引圧力)	洗浄後の最大透過液量 (㎥／㎡・day) (カッコ内は吸引圧力)
実施例１	０．４４ (－０．３２kg／cm)	１．３３ (－０．３２kg／cm)
比較例１	０．４４ (－０．３２kg／cm)	０．７４ (－０．３３kg／cm)
比較例２	０．４４ (－０．３２kg／cm)	０．８９ (－０．３３kg／cm)

【００４７】表１より、蛋白質分解酵素及び脂質分解酵素と過酸化水素による本発明の洗浄方法によれば、カセイソーダと塩酸、又は、次亜塩素酸ソーダと塩酸を用いる従来の洗浄方法に比べて、１．５～１．８倍の最大透過液量を得ることができ、洗浄効率が大幅に改善されることが明らかである。

【００４８】

【発明の効果】以上詳述した通り、本発明の浸漬型膜分離装置の洗浄方法によれば、

① 膜の洗浄を効率的に行うことができるため、洗浄頻度を低減できる。

② 酵素による洗浄で、取り扱い上危険な薬品を必要としないため、洗浄作業が容易で、専門の作業員による高度な管理も不要となる。

③ 洗浄排液を生物処理反応槽内に排出することが可能となるため、洗浄排液処理が不要となる。

④ 洗浄排液中に残留している酵素を生物処理反応槽内＊液中の蛋白質や脂質の酵素分解に、また、過酸化水素を活性汚泥の酸素供給源として、それぞれ有効に活用できる。

といった効果が奏され、好気性生物処理反応槽又は、これに連結された槽内に浸漬設置された膜分離装置を高い安全性にて効率的に洗浄することができる。

【図面の簡単な説明】

【図１】本発明の一実施例方法を示す系統図である。

【符号の説明】

1　曝気槽
2　曝気管
3　中空糸膜分離装置
4　減圧ポンプ
5　蛋白質分解酵素含有洗浄水貯槽
6　脂質分解酵素含有洗浄水貯槽
7　過酸化水素含有洗浄水貯槽

【図１】